INDIAN AND NORTHERN AFFAIRS CANADA
NORTHERN AFFAIRS PROGRAM

SUMMARY REPORT:
DRILLING FLUID USE AND WASTE DISCHARGE
IN
ARCTIC MARINE WATERS NORTH OF 60°
FOR 1983

Arctic Waters Section
Water Resources Division

January 1986

SUMMARY

Hydrocarbon exploration operators in arctic marine waters North of 60° are required to report to COGLA various data on drilling fluid additives and wastes discharged to the marine environment. In 1985, a report summarizing data for the years 1978 to 1982 was prepared by the Arctic Waters Section, Water Resources Division of the Department of Indian Affairs and Northern Development. That report recommended that the Section continue to compile annual reports on these data to observe developing trends.

This report summarizes the data reported by four (4) operators active in hydrocarbon exploration in arctic marine waters North of 60° for the year 1983. Problem areas have been identified and recommendations made for further work in compiling future annual reports.

Milburn, D. and D.L.S. Edwards, "Summary Report: Drilling Fluid Use and Wastes Discharge in Arctic Marine Waters North of 60° for 1983." Arctic Waters Section, Water Resources Division, Northern Affairs Program, Indian and Northern Affairs Canada, Yellowknife, N.W.T. 44 pages.

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1. INTRODUCTION

Hydrocarbon exploration companies conducting operations on Canada Lands are required to obtain an Authority to Drill a Well (ADW) issued by the Canada Oil and Gas Lands Administration (COGLA) under the authority of the Canada Oil and Gas Act (COGA). Attached to the ADW for offshore wells North of 60^0 are Environmental Operating Conditions (EOC) provided by the Northern Affairs Program (NAP) of the Department of Indian Affairs and Northern Development (DIAND). The EOC are developed through consultation with the Arctic Water Advisory Committee (AWAC), an interdepartmental committe with public representation. The EOC require an operator to submit to COGLA prior to spud date, a list of drilling fluid additives and base materials anticipated for use in the drilling fluid program and the expected mass or volume of each component. The EOC also require the operator to report after rig release, data on the following:

a) the total mass and types of each drilling fluid additive, specialty compound or other products used in the mud system including the amount of oil from all sources entering the drilling fluid;

b) the daily and total mass of drilling wastes discharged; and

c) the volume of mud tank contents discharged and the date and reason for discharge.

Through compilation and reduction of these reported data, comparisons can be made of the types and quantities of drilling fluid additives anticipated for use in the mud program and the actual quantities used. Summaries of total loadings and a comparison of wastes discharged to the arctic marine environment at the wellsites are also produced. These data can augment impact assessment studies at wellsite locations as well as assist resource managers in assessing the effectiveness of mitigative measures applied to the hydrocarbon exploration industry.

2. BACKGROUND

For the year 1983, four hydrocarbon exploration operators were actively involved in exploration in arctic marine waters. The companies and the wells drilled were:

1. Dome Petroleum Limited, Calgary, Alberta

    Aiverk 21-45
    Arluk E-90
    Havik B-41
    Natiak O-44
    Siuluk I-05
    Uviluk P-66

2. Esso Resources Canada Limited, Calgary, Alberta

    Itiyok I-27
    Kadluk O-07

3. Gulf Canada Resources Inc., Calgary, Alberta

    Amauligak I-44
    Kogyuk N-67
    Pitsuilak A-05

4. Panarctic Oils Limited, Calgary, Alberta

    Cape MacMillan K-15
    Cape MacMillan 2K-15
    Cisco K-58
    Grenadier A-26

The locations of these wells are shown in Figures 1 and 2.

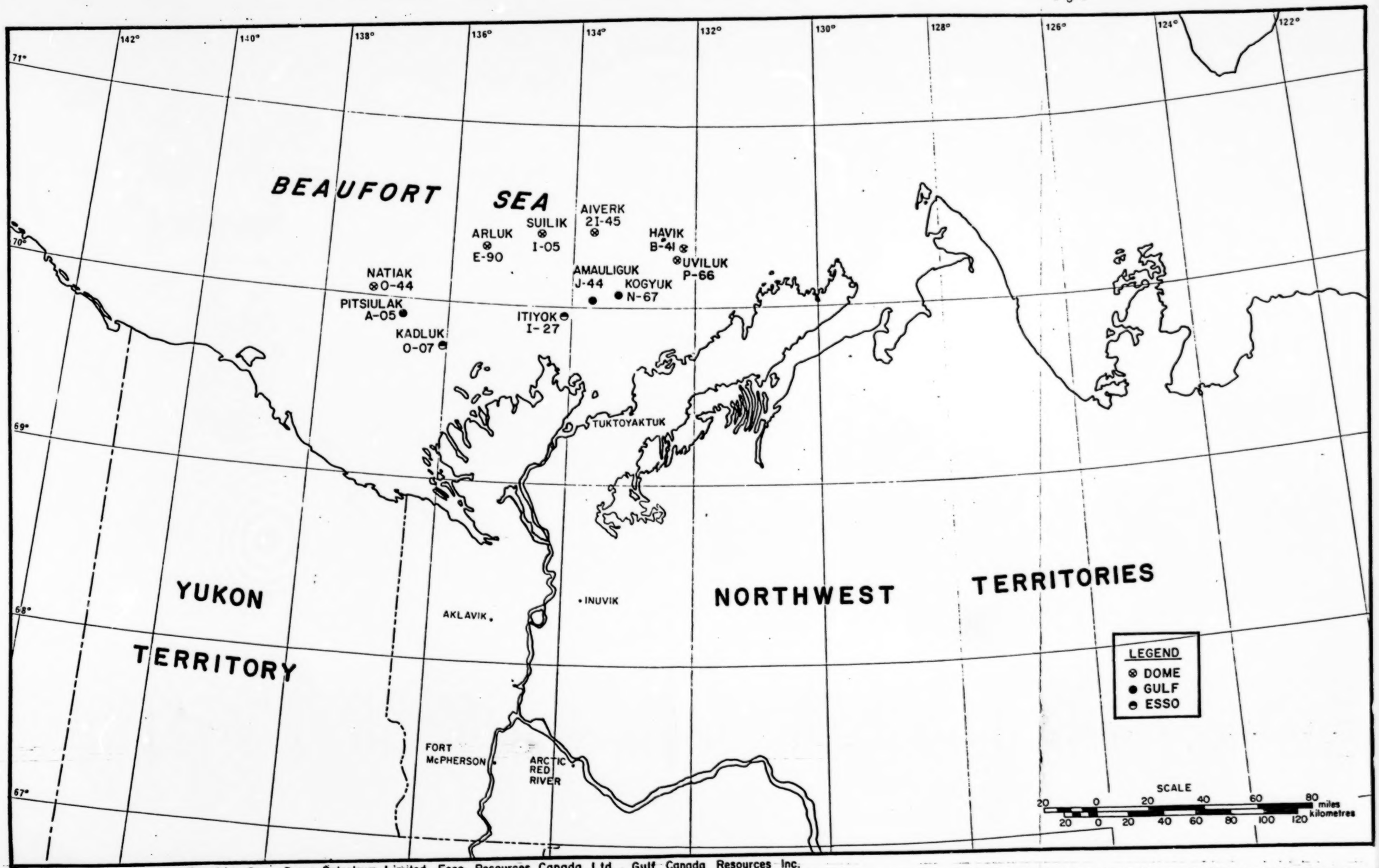

Fig: 1 Location of Wells - Beaufort Sea - Dome Petroleum Limited, Esso Resources Canada Ltd., Gulf Canada Resources Inc.

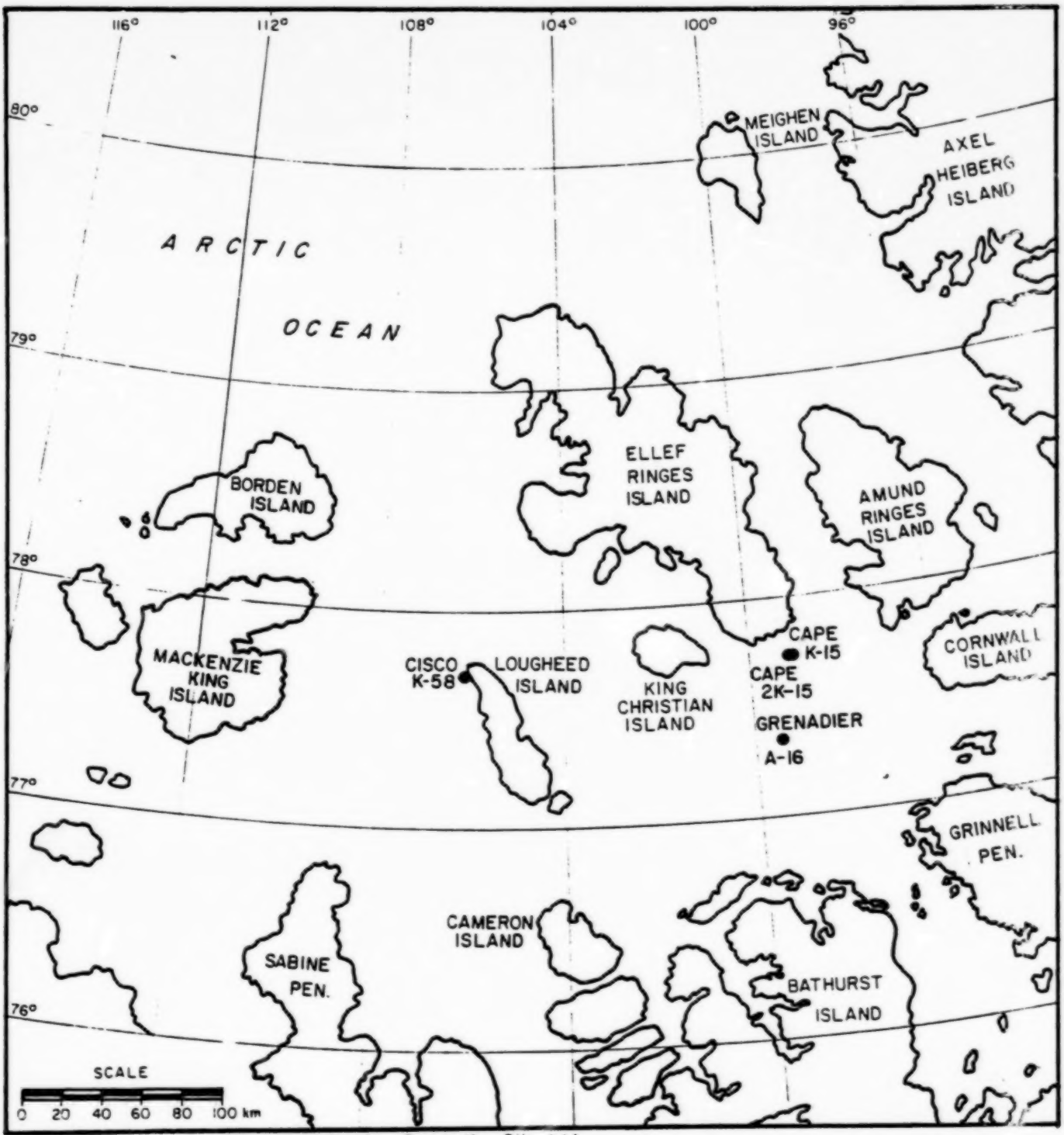

Fig:2 Location of Wells - High Arctic - Panarctic Oils Ltd.

As required by the EOC, the operators submitted to COGLA prior to the spud date, lists of drilling fluid additives and base materials, and their anticipated mass or volumes to be used in the drilling program. Upon rig release, the operators also submitted to COGLA, reports on the mass and types of drilling fluid additives, specialty compounds and other products used in the drilling program, as well as the volumes of wastes discharged. If oil was used in a mud system, as in the use of a diesel pill to free a stuck pipe, its volume was also recorded.

Preliminary collection of data was restricted to the reports submitted to COGLA, Yellowknife, N.W.T. To complete data collection, however, several contacts with company officials were required.

As indicated in a previous report on drilling fluid usage and waste discharge, some of the data provided by the companies were incomplete or incorrect.[1]. Problems that were experienced in assembling and reducing these data for this report include:

a) incomplete reports - the data submitted was too general. As an example, one report listed "volume discharged" but did not indicate what was discharged. It must be noted that in these instances the EOC did not specifically require this detailed information;

b) inaccurate submissions - values reported frequently contained arithmetic errors. Values reported occasionally had more than one or no units specified which created uncertainty. Confirmation of reported values was required; and

c) poor record keeping - reports submitted were in some cases illegible. Too much information in too little space led to confusion regarding actual values attached to chemical usage. Again, confirmation of reported values was required.

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1. Evans T.B. and D. Milburn; "Drilling Mud Usage and Discharge in Arctic Marine Waters North of 60^{o} for the Period 1978-1982"; Water Resources Division, Northern Affairs Program, Indian and Northern Affairs Canada, Yellowknife, N.W.T. 46 pages.

As with the report "Drilling Mud Usage and Discharge in Arctic Marine Waters North of 60^{0} for the Period 1978-1982" (Evans and Milburn, 1985), this report serves as a summary of submitted data and a first step in data reduction. Statistical analysis of these data was not contemplated for this report but depending on the final uses of the data presented, future reports may include data analysis. However, in this report simple regression analysis was used to produce the line of best fit for the mass of selected drilling fluid components vs. well depth. The components selected were based primarily on frequency of use. The seven drilling fluid components, are used in standard formulations of KCL polymer muds and are used exclusively in arctic drilling. The lines of best fit and their formulae are shown in Figures 3. to 9. Caution is urged in the interpretation of these regression analyses as the accuracy of the formulae may not be high due to the low number of samples and varying well conditions.

The data submitted by the four hydrocarbon exploration operators for the period 1983 are grouped in the following tables:

1. Summaries of Drilling Fuild Additives Used by Well;

2. Comparison of Estimated and Actual Drilling Fluid Additives Used; and

3. Drilling Waste Volume by Well.

In an effort to ease interpretation of the tabular summaries, Appendix I provides an alphabetical list of all drilling fluid additives reported by one or more operators and a grouping of these compounds showing the most common designation and other frequently used names.

3. OBSERVATIONS

1. A wide variability in the quality of data reported was observed. Even among the individual company's operational reports, there was a tendency for the quality of reporting to vary.

2. Barite and potassium chloride were used to the greatest extent in drilling operations while caustic soda, soda ash, sodium bicarbonate and bentonite were used to a lesser degree. Remaining additives were used less frequently and their use was dependent on downhole conditions.

3. There was a positive correlation between the mass of major drilling fluid additives used and depth of the well.

4. The greatest quantity of waste discharged was consistently designated as "mud". The lowest quantity of waste discharged was hydraulic fluid used in testing the BOP stack. Equal quantities of cuttings and solids control wastes were usually discharged.

5. Through comparison of the estimated and actual usage of drilling fluid additives it was observed that there is often agreement for the major constituents although there is a tendency to overestimate the use of the minor constituents.

4. DISCUSSION AND RECOMMENDATION

1. To overcome problems incurred in assembling incomplete or inaccurate data, the reported data must be reviewed upon receipt and discrepancies addressed immediately to the operator.

2. To facilitate the compilation and processing of the data, standard forms for reporting data are recommended.

3. As the data base expands for the information presented in this report and subsequent reports, further treatment of the data is recommended.

4. At present most data is reported as tons, drums, sacks, pails and gallons. It is recommended that the EOC be revised to request the operators to submit the data in S.I. units.

5. It is recommended that the Arctic Waters Section, Water Resources Division, NAP, INAC, continue to compile these summary reports.

6. It is recommended that the EOC requiring the submission of reports for anticipated and actual drilling use and waste discharge be retained.

5. APPENDIX I

DRILLING FLUID ADDITIVES REPORTED
BY ONE OR MORE OPERATOR

Drilling Fluid Additives Reported by One or More Operator

Drilling Fluid Additive	Function
Aluminium Stearate	Defoamer
AP-21	Filtrate Reducer
Attapulgite Gel	Viscosifier
Bardac 2250	Bactericide
Barite	Weighting Material
Bentonite	Viscosifier, Filtrate Reducer
B-Free; regular, heavy wate	Surfactant, Lubricant
Bicarbonate of Soda	Calcium Treating
Calcium bromide	Packing Fluid
CaCl	Freeze Depressant, Cement Accelerator
Capyrl Alcohol	Defoamer
Caustic Soda	pH Control
Carbonox	Filtrate Reducer, Dispersant
Cellophane	Filtrate Reducer
Chrom Alum	Lost Circulation Material
CMC	Filtrate Reducer
Coat 129	Corrosion Inhibitor
Coat 888	Corrosion Inhibitor
Defoamer	Defoamer
Desco	Thinner
DF-Vis	Filtrate Reducer, Viscosifier
Diesel	Lubricant
Drispac - Reg., Superlo	Filtrate Reducer, Viscosifier
DX-10	Surfactant
Foam Kontrol	Surface Active Liquid Defoamer
FLR-100 (FLR-100E)	Lost Circulation Material
Friction Ease	Lubricant

Gel (Bentonite)	Filtrate Reducer, Viscosifier
Gilsonite	Lost Circulation Material, Shale Control
IDFlo	
IDF-Thin	Lost Circulation Material
Imco Fibre	Dispersant
	Lost Circulation Material
K1D-97	Viscosifier
Kelzan XC/XCD/XCL	Viscosifier
Kwik Seal	Lost Circulation Material
Lignite	Filtrate Reducer
Lime	pH Control
Lubraglide	Lubricant
Magconol	Defoamer
Mica	Lost Circulation Material
Nickel Sulphate	Catalyst for Oxygen Scavenger
Noxygen	Corrosion Inhibitor
Nut Hulls	Loss Circulation Material
Nut Plug	Loss Circulation Material
Paraformaldehyde	Bactericide
Peltex	Thinner, Dispersant
Poly Rx	Dispersant
Potassium Chloride	Shale Inhibitor, Freeze Depressant
Potash	Shale Inhibitor, Freeze Depressant

Safeguard 5000	
Salt	Flocculent
SAPP	Thinner, Dispersant
Sawdust	Lost Circulation Material
SMR	Viscosifier
Soda Ash	Calcium Treating
Sodium Bicarbonate	Calcium Treating
Sureflo H-35	Scale Inhibitor
Sodium Nitrate	Tracing Fluid
Sodium Sulphite (Sulfite)	Corrosion Inhibitor
Soltex	Mud Conditioner
Spersene	Filtrate Reducer, Dispersant
SST	Shale Inhibitor
Staflo-Lo, reg.	Filtrate Reducer
Surflo W-300	Defoamer
Tannathin	Thinner, Dispersant
Torque Less Beads	Lubricant
Torque Trim	Lubricant
Torque Trim II	Lubricant
Unical	Thinner, Dispersant
Walnut Hulls	Lost Circulation Material
Xpel G.	Shale Inhibitor
XC Polymer (XCD, XCL included)	Viscosifier (see also Kelzan)
Zeogel	Viscosifier

6. APPENDIX II

TABLES

TABLE 1

PHYSICAL DATA OF WELLS DRILLING
IN ARCTIC MARINE WATERS
NORTH OF 60° - 1983

WELL NAME	LATITUDE/LONGTITUDE	DEPTH
Dome Aiverk 2I-45	70°24'44"N 133°42'21"W	5,028 m
Dome Arluk E-90	70°19'23"N 135°26'32"W	3,448 m
Dome Havik B-41	70°20'11"N 132°13'05"W	1,401 m
Dome Natiak O-44	70°03'57"N 137°13'07"W	3,681 m
Dome Suilik I-05	70°24'38"N 134°30'40"W	4,069 m
Dome Uviluk P-66	70°15'48"N 132°18'45"W	4,756 m
Esso Itiyok I-27	69°56'40"N 134°05'19"W	3,955 m
Esso Kadluk O-07	69°46'48"N 136°01'14"W	3,896 m
Gulf Amauligak J-44	70°03'31"N 133°42'45"W	2,326 m
Gulf Kogyuk N-67	70°06'50"N 133°19'47"W	4,798 m
Gulf Pitsiulak A-05	69°54'14"N 136°45'35"W	1,725 m
Panarctic Cape MacMillan K-15	77°44'45"N 99°06'59"W	532 m
Panarctic Cape MacMillan 2K-15	77°44'45"N 99°06'59"W	2,090 m
Panarctic Cisco K-58	77°27'33"N 106°21'15"W	2,240 m
Panarctic Grenadier	77°24'04"N 99°34'56"W	2,766 m

Source: The Canada Oil and Gas Lands Administration Annual Report, 1983, pp.32-35.

SUMMARIES OF DRILLING FLUID ADDITIVE

USED BY WELL

TABLE 2: DOME PETROLEUM LIMITED

DRILLING FLUID ADDITIVE USE BY WELL

(all units are in kg unless otherwise indicated)

Chemical	Aiverk 2I-45	Arluk E-90	Havik B-41	Natiak O-44	Siuluk I-05	Uviluk P-66	Total
Aluminum Stearate	-	-	-	-	-	68.1	68.1
AP 21(1)	260.0	1,280.0	-	-	1,440.0	17,320.0	20,300.0
Barite	2,240,100.0	1,717,000.0	704,370.0	2,747,520.0	1,640,860.0	2,297,500.0	11,347,350.0
Bentonite	2,179.2	-	-	161,669.4	-	120,128.0	283,976.6
B free (1)	-	-	-	-	1,435.0	500.0	1,935.0
Carbonox	1,452.8	-	-	-	-	-	1,452.8
Caustic Soda	17,320.1	6,605.7	4,063.3	58,618.7	16,843.4	32,370.2	135,821.4
Cellophane	-	-	-	-	-	56.8	56.8
CMC	-	1,816.0	-	-	908.0	-	2,724.0
Desco	-	4,199.5	283.0	-	1,101.0	14,357.8	19,941.3
DF Vis	1,000.0	1,775.0	1,000.0	1,500.0	75.0	-	5,350.0
Drispac - regular	1,248.5	930.7	760.5	3,541.2	658.3	5,459.4	12,598.6
- superlo	774.8	647.0	65.8	6,594.4	1,498.2	-	9,580.2
DX 10(1)	9,080.0	590.2	227.0	4,305.0	1,997.6	1,953.1	18,152.9
Flr 100	-	12,225.0	12,700.0	-	25.0	-	24,950.0
Friction Eaze (1)	-	-	-	-	820.0	-	820.0
Gel*	16,920.0	800.0	17,840.0	-	24,160.0	-	59,720.0
IDFlo	4,175.0	-	4,675.0	-	9,875.0	-	18,725.0
IDF Thin	26,450.0	15,400.0	100.0	80,725.0	39,000.0	98,925.0	260,600.0
KCL (Potash incl)	53,250.0	-	28,900.0	103,687.0	108,815.0	347,425.0	642,077.0
Kelzan (XC+XCD)	454.0	2,678.6	317.8	3,405.0	499.4	1,997.6	9,352.4
Kwik Seal	-	-	-	-	363.2	749.1	1,112.3
Lime	-	-	-	-	160.0	-	160.0
Magconol (1)	205.0	-	46,945.0	2,255.0	1,025.0	2,248.0	52,678.0
Mica	-	-	-	-	450.0	2,150.0	2,600.0
N'oxygen	-	500.0	-	2,875.0	300.0	-	3,675.0
Nut Plug	-	-	-	-	227.0	2,724.0	2,951.0
Poly Rx	-	-	-	-	-	10,532.8	10,532.8
Safeguard 5000(1)	-	-	-	47,150.0	-	1,000.0	48,150.0
SAPP	90.8	41,177.8	12,939.0	181.6	-	45.4	54,434.6
Shale Kontrol	-	3,495.8	-	-	2,065.7	-	5,561.5
SMR	-	40,450.0	27,025.0	13,200.0	6,475.0	2,375.0	89,525.0
Soda Ash	3,813.6	2,270.0	544.8	6,310.6	3,268.8	4,449.2	20,657.0
Sodium Bicarbonate	2,360.8	1,634.4	590.2	106,826.2	181.6	10,305.8	121,899.0
Sodium Sulphite	725.0	-	-	-	800.0	-	1,525.0
Soltex	4,131.4	-	-	-	-	-	4,131.4
SST	13,665.4	-	-	-	9,874.9	15,980.8	39,520.8
Staflo - regular	158.9	-	1,066.9	-	204.3	-	1,430.1
- lo	-	-	-	-	635.6	-	635.6
Technisperse	5,107.5	10,056.1	-	-	1,816.0	-	16,979.6
Torque Trim (1)	410.0	-	-	1,230.0	2,460.0	13,740.0	17,840.0
Walnut Hulls	-	681.0	-	-	998.8	-	1,679.8
W-300 (1)	11,890.0	-	6,355.0	-	-	2,998.0	21,243.0
X-Pel-G	-	-	-	-	3,632.0	-	3,632.0

*Wyoming Bentonite or Zeogel

TABLE 3: ESSO RESOURCES CANADA LIMITED

DRILLING FLUID ADDITIVE USE BY WELL

(in kg unless otherwise indicated)

Chemical	Itiyok 1-27	Kadluk 0-07	Total
Aluminum Stearate	-	204.0	204.0
Barite	539,845.0	2,950,320.0	3,490,165.0
Bentonite	21,571.0	40,988.0	62,559.0
B free (l) - heavy wate	-	2,130.0	2,130.0
- regular	-	1,200.0	1,200.0
Capryl Alcohol (l)	425.0	205.0	630.0
Caustic Soda	16,532.8	25,500.0	42,032.8
Diesel (l)	-	53,800.0	53,800.0
Drispac	3,769.7	7,023.0	10,792.7
Gilsonite	-	19,259.0	19,259.0
IDFlo	14,850.0	23,100.0	37,950.0
KCL	14,564.0	11,927.0	26,491.0
Paraformaldehyde	824.1	341.0	1,165.1
Peltex	2,180.0	11,556.0	13,736.0
Sawdust	1,475.5	4,158.0	5,633.5
Soda Ash	1,712.4	640.0	2,352.4
Sodium Bicarbonate	1,705.0	8,909.0	10,614.0
Sodium Sulphite	5,597.0	10,550.0	16,147.0
Unical	-	7,016.0	7,016.0
XC Polymer	17,817.0	11,321.0	29,138.0

TABLE 4: GULF CANADA RESOURCES INC.

DRILLING FLUID ADDITIVE USE BY WELL

(all volumes are in kg unless otherwise stated)

Mud Chemical	Amauligak J-44	Kogyuk N-67	Pitsuilak A-05	Total
Ap-21 (1)	1,824.0	6,631.0	-	8,455.0
Barite	1,230,000.0	1,912,500.0	763,100.0	3,905,600.0
B free (1)	5,330.0	-	-	5,330.0
Brine (1)	148,000.0	-	112,000.0	260,000.0
Caustic Soda	7,400.0	14,160.0	3,280.0	24,840.0
Defoam (1)	205.0	-	-	205.0
Diesel (1)	45,000.0	-	-	45,000.0
Drispac	11,680.0	13,520.0	4,720.0	29,920.0
Dx10 (1)	4,920.0	24,395.0	5,330.0	34,645.0
Foam Kontrol (1)	205.0	820.0	461.3	1,486.3
IDFlo	10,720.0	-	12,520.0	23,240.0
KCL	75,200.0	316,200.0	37,920.0	429,320.0
Lubraglide	1,600.0	-	-	1,600.0
Noxygen	-	-	160.0	160.0
Nut Hulls	3,200.0	-	-	3,200.0
Nut Plug	2,040.0	-	-	2,040.0
Safeguard 5000 (1)	615.0	-	-	615.0
SAPP	360.0	320.0	-	680.0
Soda Ash	5,240.0	9,200.0	5,120.0	19,560.0
Sodium Bicarbonate	1,160.0	1,120.0	1,080.0	3,360.0
Sodium Nitrate	-	520.0	-	520.0
Sodium Sulphite	1,800.0	-	-	1,800.0
Staflo X-Lo	-	5,760.0	-	5,760.0
Technisperse (1)	-	288.0	-	288.0
Torq trim	-	4,920.0	-	4,920.0
XC (Kelzan)	18,720.0	1,040.0	-	19,360.0
XCD	1,560.0	34,040.0	17,280.0	52,880.0
XCL	-	18,200.0	-	18,200.0

TABLE 5: PANARCTIC OILS LTD.

DRILLING FLUID ADDITIVE USE BY WELL

(in kg unless otherwise indicated)

Chemical	Cape MacMillan K-15	Cape MacMillan 2K-15	Cisco K-58	Grenadier A-26	Total
Attapulgite	5,856.6	11,894.8	29,503.0	11,213.8	58,468.2
Barite	31,880.0	174,000.0	260,642.0	120,600.0	587,122.0
Bentonite	3,904.4	2,860.2	3,725.0	2,724.0	13,213.6
Caustic Soda	998.8	3,359.6	7,273.0	5,629.6	17,261.0
CMC	1,135.0	1,362.0	-	2,201.9	4,698.9
Coat 129 (1)	-	-	945.0	-	945.0
KCL	-	-	59,184.0	-	59,184.0
Kelzan X.C.	2,900.0	5,525.0	7,537.0	4,925.9	20,887.9
Kwik Seal (Imco Fybre)	-	-	271.0	-	271.0
Lignite	-	1,021.5	-	-	1,021.5
Mica	-	-	1,250.0	-	1,250.0
Nickel Sulphate	-	-	45.0	-	45.0
Salt	-	2,270.0	772.0	1,589.0	4,631.0
SAPP	-	-	454.0	-	454.0
Sawdust	-	-	10,030.0	-	10,030.0
Sodium Bicarbonate	-	1,952.2	590.0	499.4	3,041.6
Spersene	-	454.0	-	1,090.1	1,544.1
Staflo	-	1,025.0	5,560.0	1,589.0	8,174.0
Surflo H-35 1	-	-	265.0	-	265.0
Tannithin	-	908.0	-	-	908.0
Walnut Hulls	-	-	636.0	-	636.0

COMPARISON OF ESTIMATED AND ACTUAL

DRILLING FLUID ADDITIVES USED

TABLE 6: DOME PETROLEUM LIMITED

COMPARISON OF ESTIMATED AND ACTUAL DRILLING FLUID ADDITIVE USE

(all units are kg unless otherwise indicated)

Chemical	Estimated as required (AR)	Actual
Aluminum Stearate		68.1
AP 21 (1)	28,000.0	20,300.0
Barite	22,000,000.0	11,347,350.0
Bentonite	500,000.0	283,976.6
B free (1)	A.R.	1935.0
Bicarbonate of Soda	20,000.0	121,899.0
Carbonox	A.R.	1,452.8
Caustic Soda	215,000.0	135,821.4
Cellophane	A.R.	56.8
CMC	7,000.0	2,724.0
Desco	27,000.0	19,941.3
DF Vis	A.R.	5,350.0
Drispac - regular	15,000.0	12,598.6
- superlo	82,000.0	16,580.2
Dx 10 (1)	A.R.	18,152.9
Flr 100	A.R.	24,950.0
Fricton Eaze (1)	A.R.	820.0
Gel	A.R.	59,720.0
IDFlo	87,000.0	18,725.0
IDF Thin	350,000.0	260,600.0
KCL (Potash included)	1,682,000.0	642,077.0
Kelzan (XC + XCD)	A.R.	9,352.4
Kwik Seal	A.R.	1,112.3
Lime	A.R.	160.0
Magconol (1)	A.R.	52,678.0
Mica	A.R.	2,600.0
Noxygen	A.R.	3,675.0
Nut Plug	A.R.	2,951.0
Poly R_x	28,000.0	10,532.8
Safeguard 5000 (1)	A.R.	48,150.0
SAPP	A.R.	17,434.6
Shale Kontrol	A.R.	5,561.5
SMR	40,000.0	89,525.0
Soda Ash	48,000.0	20,657.0
Sodium Sulphite	A.R.	1,525.0
Soltex	A.R.	4,131.4
SST	135,000.0	39,520.7
Staflo - regular	A.R.	1,403.1
- lo	A.R.	635.6
Technisperse	A.R.	16,979.6
Torque Trim (1)	18,000.0	5,474.0
Walnut Hulls	A.R.	1,679.8
W-300 (1)	A.R.	21,243.0
X-pel G (Dis-Pel-G)	A.R.	3,632.0

Note: Dome did not submit individual estimates of use for each well but rather an estimate of use for the total drilling program. It should also be noted that many additives were indicated as possibly being included in the program on an as required basis and do not appear on this list, as they were not used.

TABLE 7: ESSO RESOURCES CANADA LIMITED

COMPARISON OF ESTIMATED AND ACTUAL drilling FLUID ADDITIVE

BY WELL

(all weights are in kg unless otherwise indicated)

Chemical	Itiyok I-27		Kadluk O-07	
	Estimated	Actual	Estimated	Actual
Aluminum Stearate	600.0	-	284.0	204.0
Barite	1,000,000.0	539,845.0	3,547,080.0	2,950,320.0
Bentonite	100,000.0	21,571.0	127,715.0	40,988.0
B-free (1) heavy wate	-	-	3,810.0	2,130.0
regular	-	10,000.0	440.0	1,200.0
Bicarbonate of Soda	10,000.0	1,705.0	9,773.0	8,909.0
Capryl Alcohol (1)	5,000.0	425.0	820.0	205.0
Caustic of Soda	25,000.0	16,532.8	30,000.0	25,500.0
CMC	-	-	1,496.0	-
Diesel (1)	25,000.0	-	50,000.0	53,800.0
Drispac	10,000.0	3,769.7	8,955.0	7,023.0
Gilsonite	-	-	26,632.0	19,259.0
IDFlo	40,000.0	14,850.0	32,100.0	23,100.0
KCL	180,000.0	14,564.0	40,727.0	11,927.0
Kwik Seal	5,000.0	-	1,562.0	-
Lime	2,000.0	-	572.0	-
Mica	-	-	2,640.0	-
Paraformaldehyde	1,000.0	824.1	695.0	341.0
Peltex	15,000.0	2,180.0	11,579.0	11,556.0
SAPP	3,000.0	-	100.0	-
Sawdust	15,000.0	1,475.5	18,592.0	4,158.0
Soda Ash	10,000.0	1,712.4	11,360.0	640.0
Sodium Sulphite	10,000.0	5,597.0	11,350.0	10,550.0
Torque Less Beads	10,000.0	-	-	-
Torque Trim I (1)	-	-	2,013.0	-
II (1)	10,000.0	-	-	-
Unical	-	-	10,760.0	7,016.0
Walnut Hulls	-	-	4,400.0	-
XC-Polymer	20,000.0	17,817.0	21,821.0	11,321.0

TABLE 8: GULF CANADA RESOURCES INC.

COMPARISON OF ESTIMATED AND ACTUAL DRILLING FLUID ADDITIVE

(all weights are in kg unless otherwise indicated)

Chemical	Kogyuk N-67		Pitsiulak A-05 and Amauligak I-44	
	Estimated	Actual	Estimated	Actual
AP 21 (1)	7,500.0	6,631.0	2,560.0	1,824.0
Bardac 2250	-	-	830.0	-
Barite	2,940,000.0	1,912,500.0	6,800,000.0	1,993,100.0
Bentonite	-	-	27,570.0	-
B free Heavy Wate	-	-	-	5,330.0
Brine (1)	-	-	-	260,000.0
Calcium Bromide	-	-	31,500.0	-
Calcium Chloride	-	-	9,290.0	-
Caustic Soda	7,500.0	14,160.0	14,970.0	10,680.0
Defoamer (1)	500.0	-	3,330.0	205.0
Diesel (1)	-	-	-	45,000.0
Drispac Superlo	22,750.0	13,520.0	64,850.0	16,400.0
DX-10 (1)[c]	1,000.0	24,395.0	9,990.0	10,250.0
Foam Kontrol (1)	-	820.0	-	666.3
IDFlo	23,250.0	-	69,000.0	23,240.0
IDF-Thin	-	-	5,000.0	-
KCl	210,500.0	316,200.0	500,800.0	113,120.0
K1D-97	-	-	7,980.0	-
Kwik Seal	-	-	7,310.0	-
Lime	2,000.0	-	4,800.0	-
Lubraglide	2,000.0	-	7,940.0	1,600.0
Mica	-	-	10,000.0	-
Noxygen	-	-	-	160.0
Nut Huls	-	-	-	3,200.0
Nut Plug	3,000.0	-	7,980.0	2,040.0
Safeguard 5000(1)	-	-	3,330.0	615.0
SAPP	800.0	320.0	2,400.0	360.0
Soda Ash	4,500.0	9,200.0	18,870.0	10,360.0
Sodium Bicarbonate	1,750.0	1,120.0	11,400.0	2,240.0
Sodium Nitrate	-	520.0	1,590.0	-
Sodium Sulphite	5,709.0	-	8,000.0	1,800.0
Soltex	2,750.0	-	-	-
Staflo X-Lo	-	5,760.0	-	-
Technisperse (1)	-	288.0	-	-
Torq Trim (1)	-	4,920.0	-	-
Tor-IDF	-	-	9,980.0	-
XC (Kelzan)	-	1,040.0	-	18,720.0
XCD	18,000.0	34,040.0	46,000.0	18,840.0
XCL	-	18,200.0	-	-
X-Pel-G	-	-	13,790	-

Note: Gulf did not submit individual estimates of use for each well but rather an estimated use for the Kulluk's 1983 drilling program.

TABLE 9: PANARCTIC OILS LTD.

COMPARISON OF ESTIMATED AND ACTUAL DRILLING FLUID USE

BY WELL

(all weights are in kg unless otherwise indicated)

Chemical	Cape Macmillan K-15 and 2K-15		Cisco K-58		Grenadier A-26	
	Estimated	Actual	Estimated	Actual	Estimated	Actual
Aluminum Stearate	-	-	600.0	-	-	-
Attapulgite	12,300.0	17,751.4	13,600.0	29,503.0	14,800.0	11,213.8
Barite	133,000.0	205,880.0	146,100.0	260,642.0	150,000.0	120,600.0
Bentonite	29,400.0	6,764.6	58,800.0	3,725.0	27,200.0	2,724.0
B-free (1)	1,230.0	-	1,025.0	-	1,025.0	-
Caustic Soda	15,000.0	4,358.4	24,600.0	7,273.0	15,000.0	5,629.6
CMC	600.0	2,497.0	100.0	-	1,100.0	2,201.9
Chrome Alum.	-	-	2,000.0	-	-	-
Coat 110 (1)	-	-	-	-	100.0	-
Coat 129 (1)	-	-	4,000.0	945.0	-	-
Coat 888 (1)	-	-	100.0	-	-	-
Kelzan XC	12,700.0	8,245.0	14,700.0	7,537.0	12,500.0	4,925.9
Kwik Seal (Imco Fybre)	6,000.0	-	3,800.0	271.0	1,500.0	-
Lignite	1,900.0	1,021.5	1,500.0	-	3,500.0	-
Lime	1,100.0	-	1,800.0	-	400.0	-
Mica	-	-	6,800.0	1,250.0	-	-
Nickel Sulphate	-	-	100.0	45.0	-	-
Potassium Chloride	800.0	2,497.0	80,000.0	59,184.0	750.0	-
Salt	7,800.0	2,270.0	8,700.0	772.0	7,100.0	1,589.0
SAPP	600.0	-	1,200.0	454.0	500.0	-
Sawdust	-	5,500.0	6,900.0	10,030.0	4,800.0	-
Sodium Bicarbonate	3,600.0	1,952.2	3,500.0	590.0	1,800.0	499.4
Spersene	600.0	454.0	3,200.0	-	1,500.0	1,090.1
Staflo	3,400.0	1,025.0	5,000.0	5,560.0	700.0	1,589.0
Sureflo H35 (1)	-	-	600.0	265.0	-	-
Tannathin	-	908.0	-	-	-	-
Walnut Hulls	2,200.0	-	1,200.0	636.0	1,600.0	-

DRILLING WASTE VOLUMES BY WELL

TABLE 10: DOME PETROLEUM LIMITED
DRILLING WASTE SUMMARY BY WELL
(all volumes are in m^3)

Well	Cuttings	Solids Control	Mud	Hydraulic Fluids	Total
Aiverk 21-45	421.5	616.2	1,446.0	25.1	2,508.8
Arluk E-90	486.0	1,321.0	3,177.0	23.4	5,007.4
Havik B-41	370.0	467.0	3,089.0	7.3	3,937.3
Natiak O-44	636.0	4,378.0	5,267.6	16.7	10,298.3
Siulik I-05	489.0	1,590.0	2,923.0	18.5	5,020.5
Uviluk O-66	774.8	970.1	2,377.7	-	4,122.6
Total	3,181.3	9,342.3	18,280.3	91.0	30,894.9

TABLE 11: ESSO RESOURCES CANADA LIMITED

DRILLING WASTE SUMMARY BY WELL

(all volumes are in m^3)

Well	Cuttings/Solids Control[a]	Mud	Other[b]	Hydraulic Fluids	Total
Itiyok I-27	621.24	1,243.9	1,428.3[c]	-	3,293.44
Kadluk O-07	933.03	1,885.1	-	-	2,818.13
Total	1,554.27	3,129.0	1,428.3	-	6,111.57

a - combined volumes as no hole volumes could be confirmed or obtained to allow for separate cuttings calculations.
b - discharges from Super Sump included
c - includes - $177m^3$ of mud disposed of in Sea line
- $1,250.8m^3$ of "cellar" or "tank" water
- 272.4 kg of soda ash estimated at $0.5m^3$

TABLE 12: GULF CANADA RESOURCES INC.

DRILLING WASTE SUMMARY BY WELL

(all volumes are in m^3)

Well	Cuttings	Solids Control (Desander & Desilter)	Mud	Other	Fluids	Total
Amauligak J-44	132.28	429.0	429.0	1,257.0	15.67	2,262.95
Kogyuk N-67	635.01	3,352.0	851.0	-	-	4,838.01
Pitsiulak A-05	372.56	262.0	1,303.0	320.0[a]	27.70	2,285.26
Total	1,139.85	4043.0	2,583.0	1,577.0	43.37	9,386.22

a - includes 3 diesel spotting pills circulated down hole

TABLE 13: PANARCTIC OILS LTD.
DRILLING WASTE SUMMARY BY WELL
(all volumes are in m^3)

Well	Cuttings	Solids Control (Desander & Desilter)	Mud	Other	Fluids	Total
Cape MacMillan K15	76.86	140.37	65.9	-	-	283.13
Cape MacMillan 2K15	151.64	146.6	462.0	-	16.28	776.52
Cisco K-58	155.74	281.26	202.0	-	17.99	656.99
Grenadier A26	161.14	461.23	341.0	-	19.87	983.24
Total	545.38	1,029.46	1,070.0	-	54.14	2,699.88

TABLE 14: MAJOR DRILLING FLUID ADDITIVES
WITH TOXICITY (LC_{50}) OF 1000 PPM OR LESS
USED IN ARCTIC MARINE WATERS NORTH OF 60^{o} - 1983
(all measures are in kg unless otherwise noted)

Chemical	LC_{50} Range	Beaufort Sea	High Arctic	Total
Bfree - heviwate (1)	3.1-6	2,130.0	-	2,130.0
- regular (1)	7-7.5	8,465.0	-	8,465.0
Capryl Alcohol (1)	83.0	630.0	-	630.0
Caustic Soda	105.0	202,694.2	17,261	219,955.2
Desco	105-3750	19,941.3	-	19,941.3
Diesel (1)	1-160	98,800.0	-	98,800.0
DX 10 (1)	320	52,797.9	-	52,797.9
Foam Kontrol	550	1,486.3	-	1,486.3
Lime	50-70	160.0	-	160.0
Magconol (1)	22-30	54,164.6	-	54,164.6
Nut Plug	800-5500	8,191.0	-	8,191.0
Paraformaldehyde	60	1,165.1	-	1,165.1
Safeguard 5000 (1)	120	48,765.0	-	48,765.0
SAPP	870-1700	55,114.6	454	55,568.6
Soda Ash	75	42,569.4	-	42,569.4
Soltx	230	4,131.4	-	4,131.4
Torque Trim (1)	160	22,760.0	-	22,760.0
Unical	860	7,016.0	-	7,016.0
W-300(1)	50	21,243.0	-	21,243.0

7. APPENDIX III

FIGURES SHOWING LINE OF

BEST FIT FOR SELECTED

DRILLING FLUID ADDITIVE AND WELL DEPTH

TOTAL BARITE USE BY WELL
(ALL WELLS–1983 SEASON)

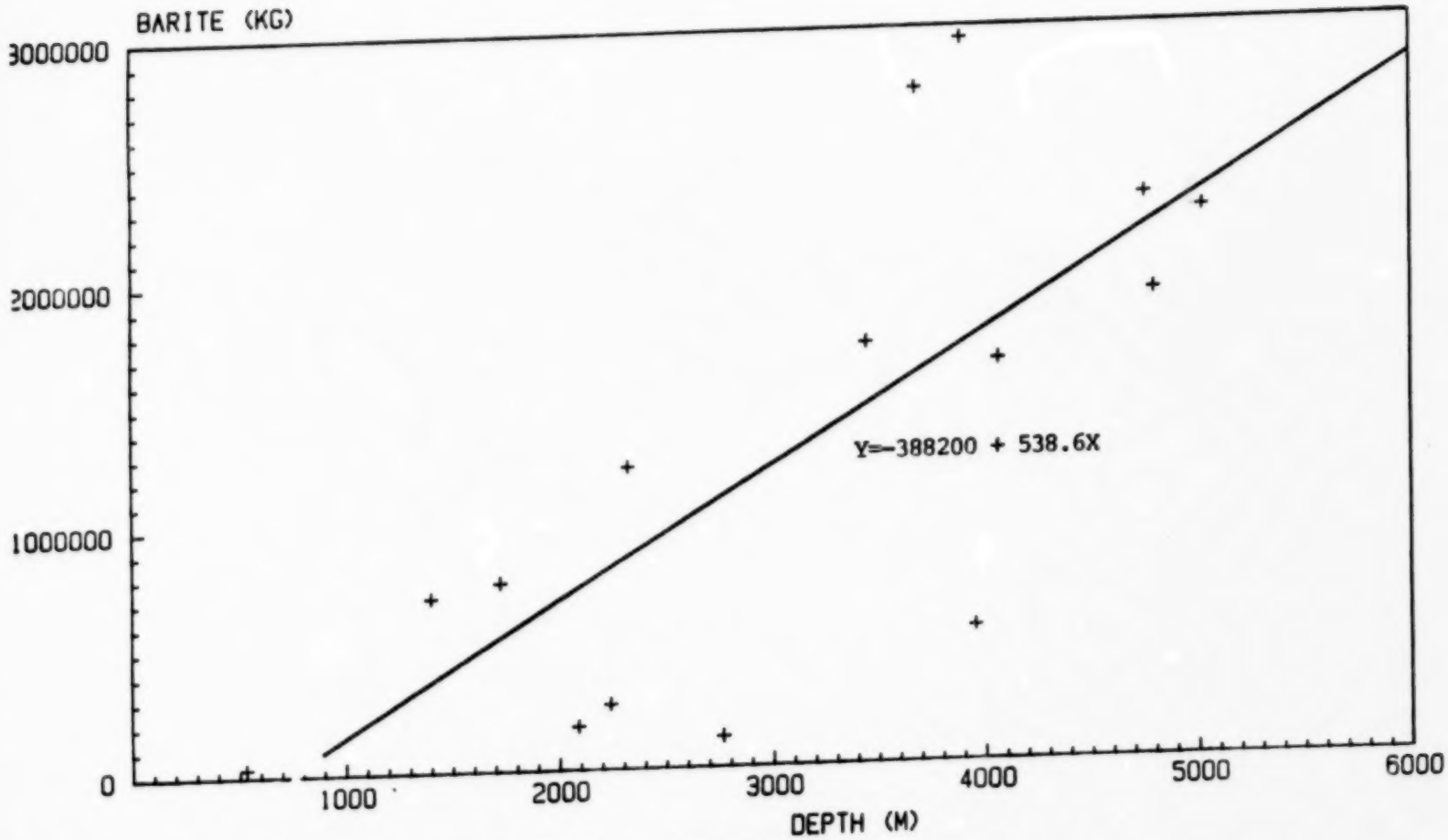

FIGURE 3 Total Barite Use by Well with Line of Best Fit

TOTAL BENTONITE USE BY WELL
(ALL WELLS–1983 SEASON)

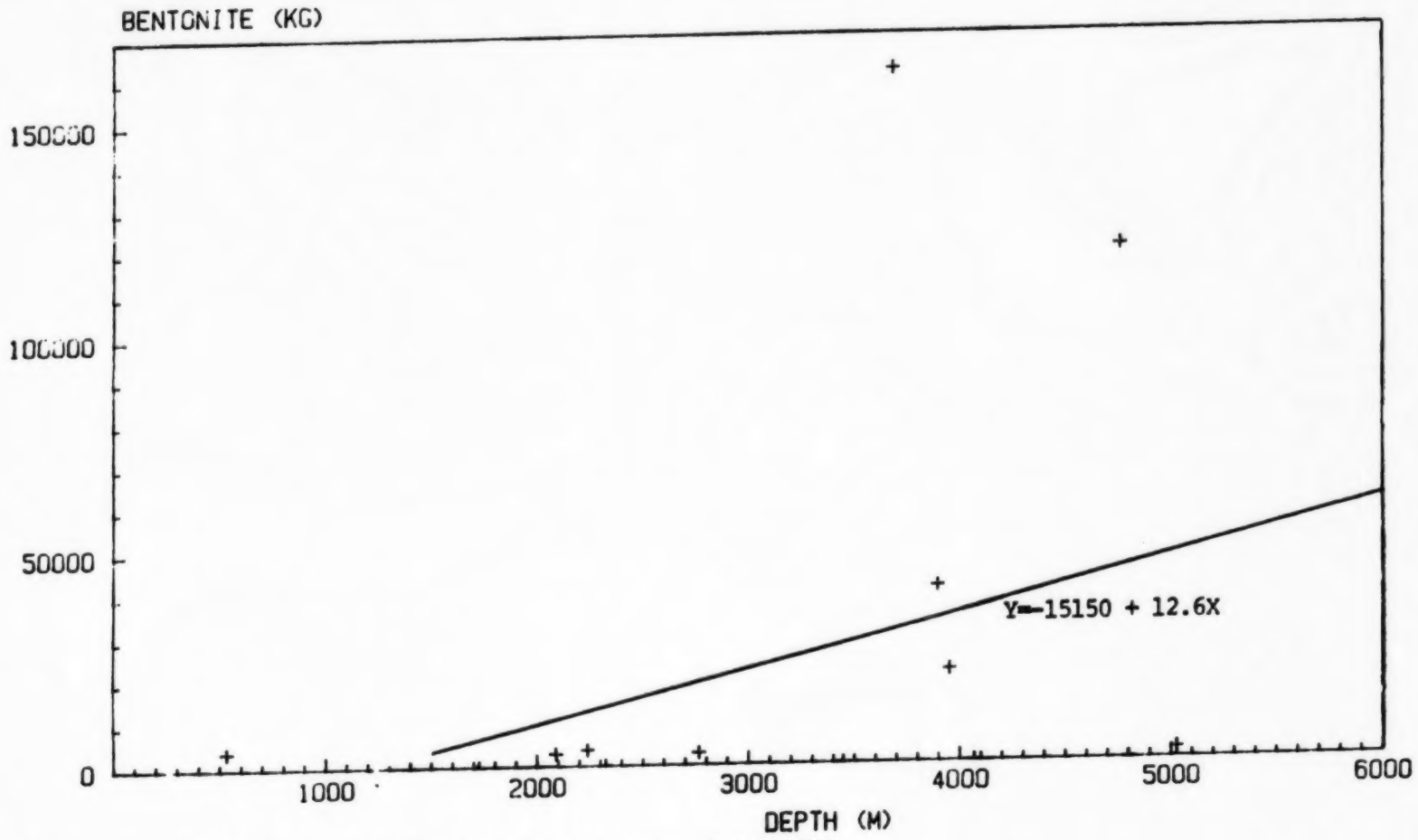

FIGURE 4 Total Bentonite Use by Well with Line of Best Fit

TOTAL BICARBONATE OF SODA USE BY WELL (ALL WELLS-1983 SEASON)

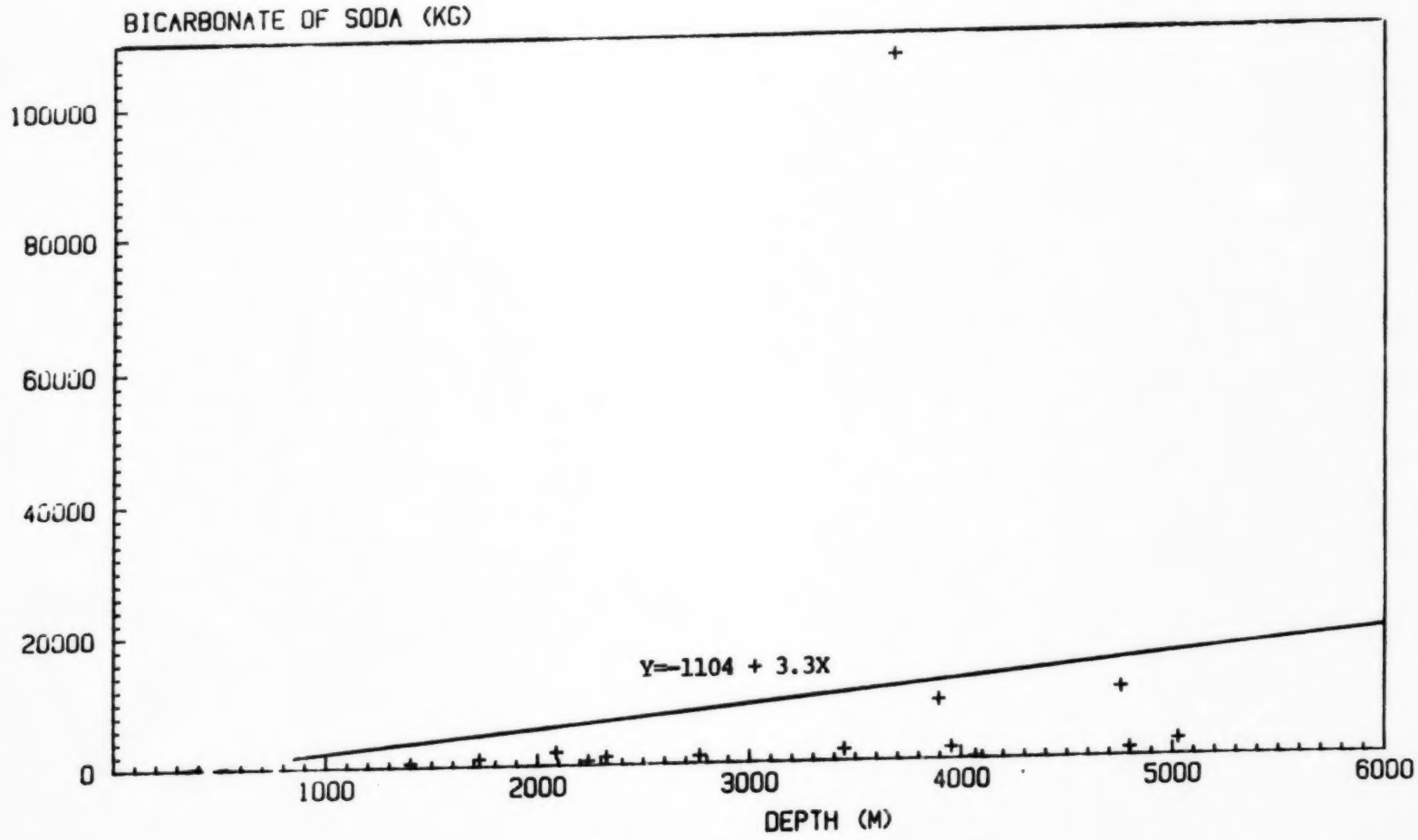

FIGURE 5 Total Bicarbonate of Soda Use by Well with Line of Best Fit

TOTAL CAUSTIC SODA USE BY WELL (ALL WELLS–1983 SEASON)

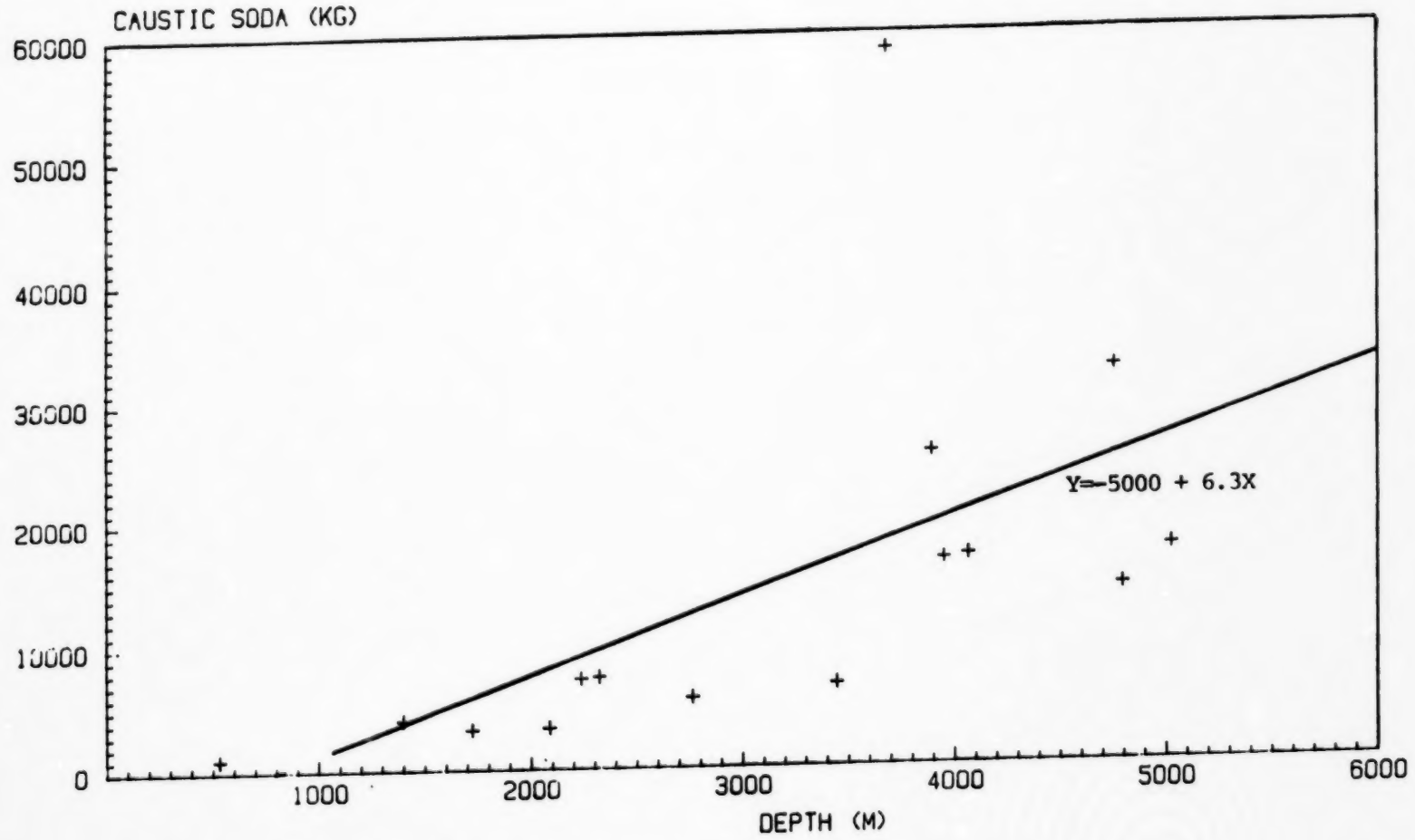

FIGURE 6 Total Caustic Soda Use by Well with Line of Best Fit

TOTAL KCL/POTASH USE BY WELL (ALL WELLS-1983 SEASON)

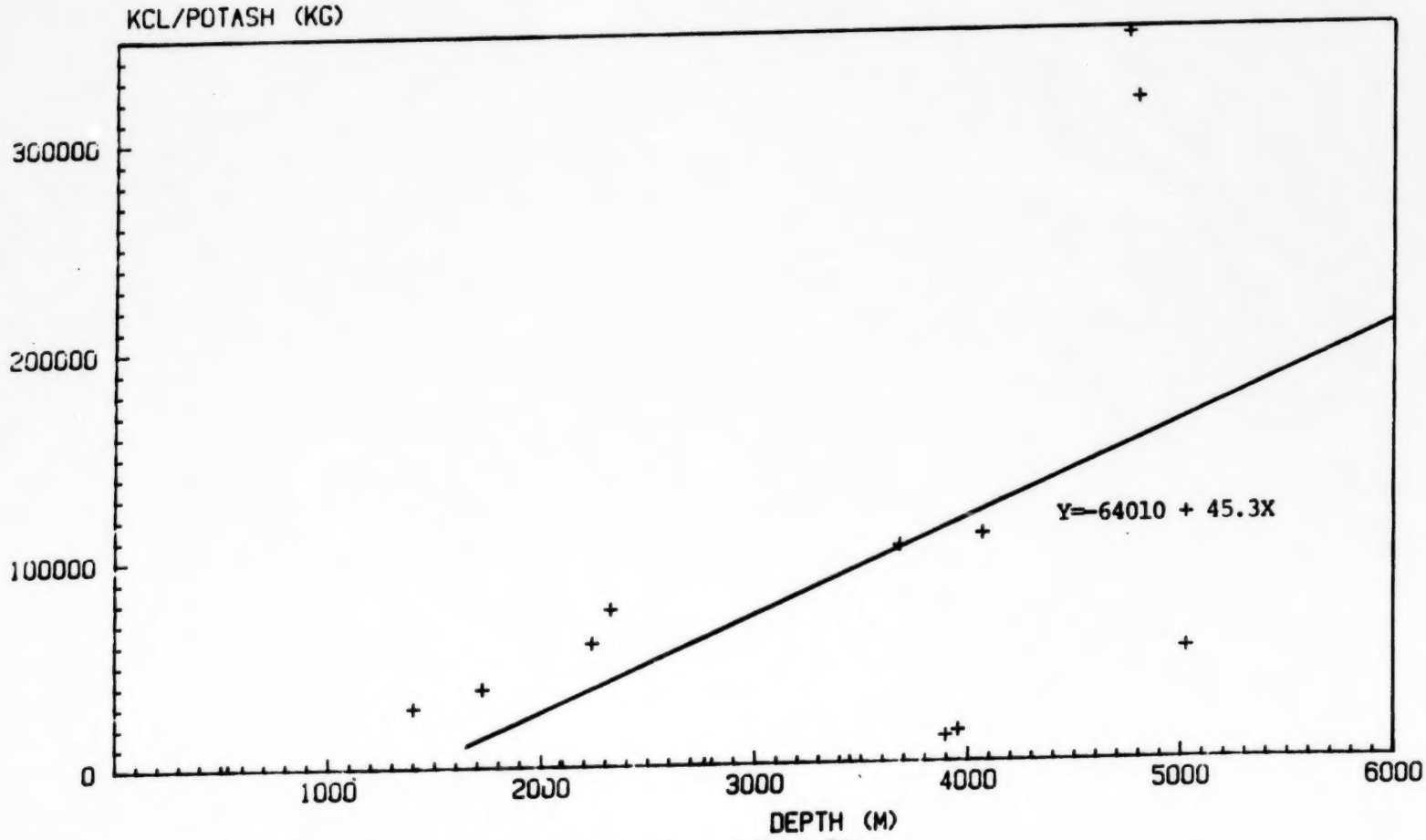

FIGURE 7 Total KCL/Potash Use by Well with Line of Best Fit

TOTAL SODA ASH USE BY WELL
(ALL WELLS–1983 SEASON)

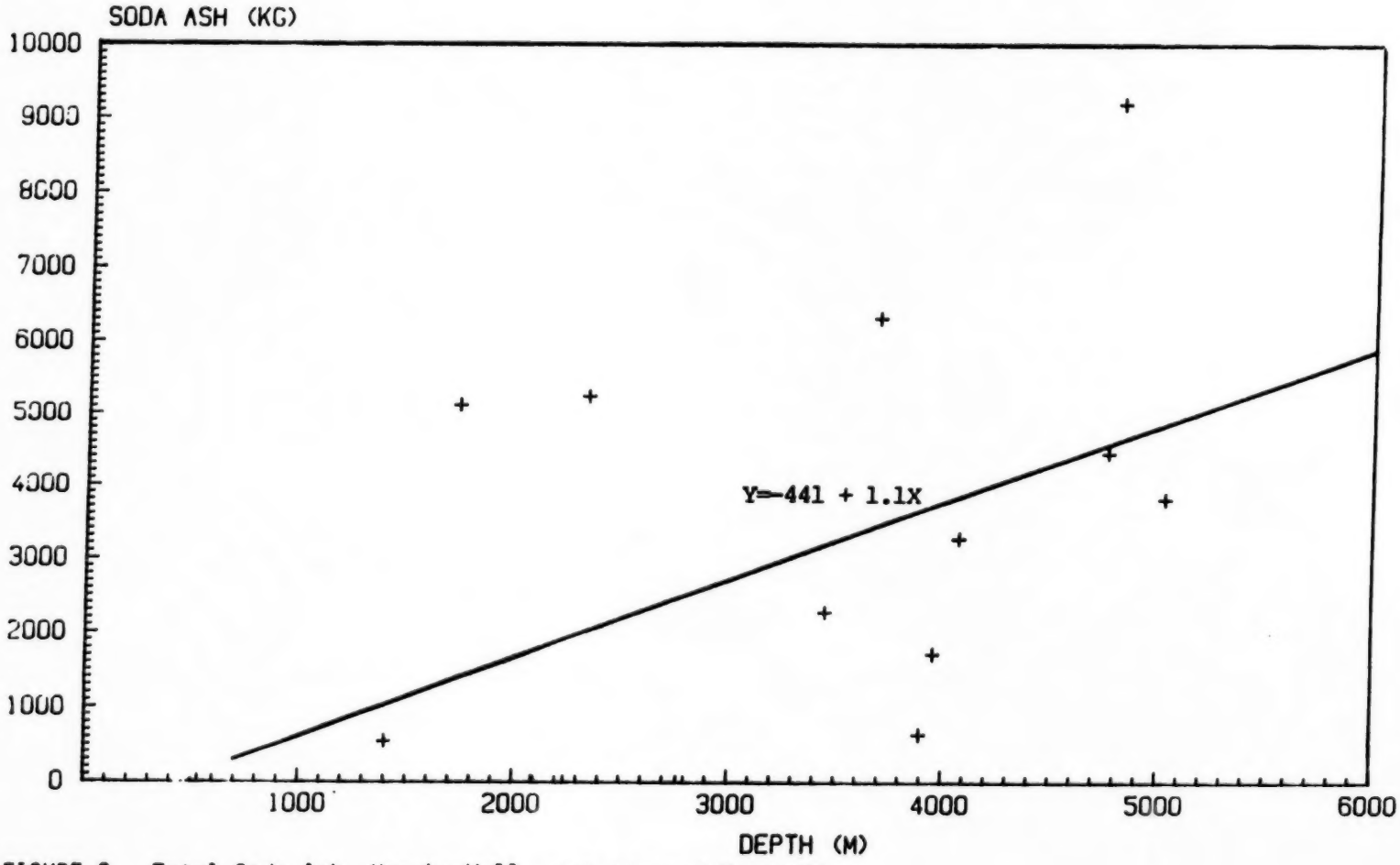

FIGURE 8 Total Soda Ash Use by Well with Line of Best Fit

TOTAL XC POLYMER USE BY WELL (ALL WELLS–1983 SEASON)

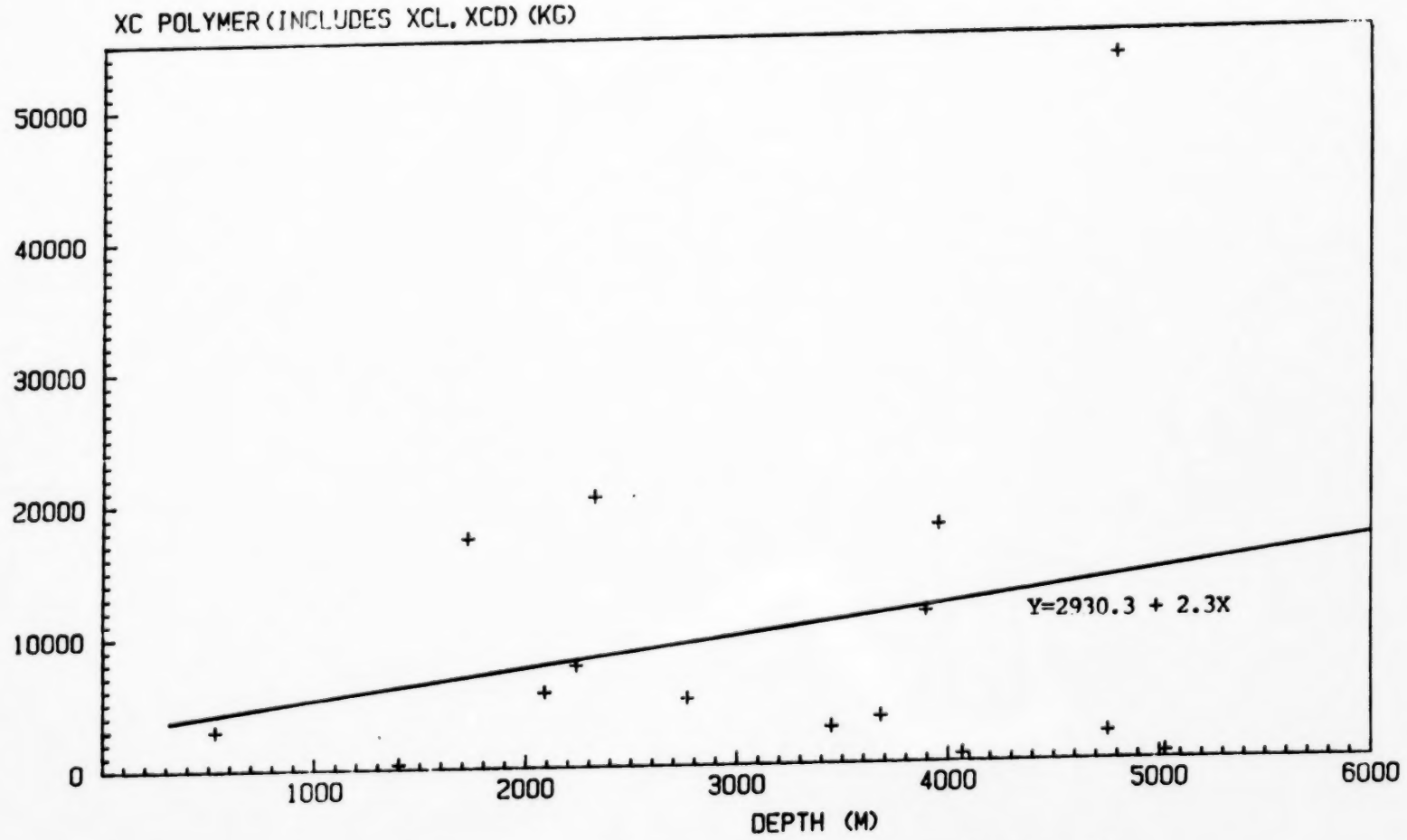

FIGURE 9 Total XC Polymer (includes XCL, XCD) Use by Wellwith Line of Best Fit